The First Report is Always Wrong, and Other Ill-Defined Aspects of the Army Battle Captain Domain

Elizabeth Owen Bratt[1], Eric Domeshek[2], and Paula J. Durlach[3]

[1] Stanford University
[2] Stottler-Henke Associates, Inc.
[3] U. S. Army Research Institute

Abstract. The position of battle captain in United States Army battalions involves responsibility for tracking a large quantity of information, communicating important information to the right people, and making decisions quickly when events deviate from plans. Soldiers assigned as battle captain in maneuver battalions have a wide variation in background and experience, yet rarely receive specific training for the role. A scenario-based intelligent tutoring system (ITS), which adapts to the incoming experience and knowledge of the student, could help fill this training gap; but the domain poses a number of challenges for defining the scope, goals and functionality of the ITS. For example, a skilled battle captain will understand that information may be untrustworthy, as well as clues to that effect. A good battle captain will also be able to adapt to the responsibilities and procedures of the particular tactical operations center (TOC), which may vary depending on the commander, the other personnel in the TOC, the location, and the mission. Defining the best course of action may not be possible (there may be multiple solutions, none of which is objectively the best). The battle captain must balance the demands of higher units for information and lower units for time to act. We discuss these issues in relation to the development of the BC-ITS training system for battle captains and its spoken language interface.

1 Introduction

In this paper, we first describe the battalion battle captain domain, and discuss various situations which involve skill and judgment. Ideally, training for new battle captains should provide opportunities to practice making decisions not only under routine conditions, but also when the routine established procedures do not yield an obvious best course of action. After reviewing the domain, we turn to potential solutions for developing an intelligent tutoring system (ITS), which can incorporate training for both the well- and ill-defined decisions a battle captain will face.

2 Battle Captain Domain

In the Army, a battalion-level battle captain is responsible for overseeing the information flow and tracking ongoing operations in the Tactical Operations Center (TOC) [7], [10]. Other personnel are primarily responsible for monitoring and logging the various information channels, such as the radio nets, e-mail, chat, and battlespace mapping and unit tracking software; but the battle captain is responsible for noticing whenever events have moved beyond the routine execution of the plans and now require actions and decisions. The battle captain, who is not necessarily a captain in rank, defers to the S3, the XO (executive officer), and the battalion commander when they are in the TOC. But these officers are frequently away from the TOC, leaving the battle captain in charge of implementing the planned operations and making decisions to support those operations when needed.

Every TOC is supposed to have a set of "recipes" known as battle drills, which dictate how the battalion staff should behave under particular circumstances (e.g., a patrol suffers a casualty). TOCs also are guided by the commander's critical information requirements (CCIRS). CCIRs are circumstances designated by the battalion commander, which directly affect his decision-making, and of which he wants to be immediately made aware. At first blush, the battle captain domain may seem well-defined, because of the reliance on battle drills, SOPs, CCIRs, and other guidelines. But it turns out that actual procedures vary from one TOC to another, being determined by environment (e.g., urban vs. rural, terrain, infrastructure), threat level, mission type (e.g., offense vs. stability), and "commander's preference." The latter means that every TOC operates somewhat differently, including the SOPs that are followed, the actual information management systems used in the TOC, and the way the commander wants to be briefed [2], [12]. Therefore, training a new battle captain on a particular set of battle drills would be inappropriate. The battle captain will need to adapt behavior to suit both circumstances and superior's expectations. Moreover, real-world events often involve more complexity than laid out in battle drills, and unforeseen conditions may arise. In Army doctrine "exceptional information" results from an unexpected event, such as an unforeseen opportunity for success or an early warning of an unforeseen threat. By its nature, identifying exceptional information relies on the initiative of subordinate commanders and the staff. Thus, an important part of the battle captain's job is turning information into understanding and being proactive with it. The challenge for the development of an ITS is encoding these skills and determining the best way to train and assess them.

3 Ill-Defined Aspects of the Domain

The battle captain domain fits the criteria of an ill-defined domain [6], [1], because the areas where training is seen as most useful are those for which established procedures do not determine the battle captain's actions, and the battle

captain must use intelligence, foresight, and judgment [12]. Two of these areas are described in more detail below.

3.1 When to Act

Experienced battle captains when describing how to react to a new battlefield event often state that *The first report is always wrong* [4], [12]. The reader need only reflect on the Fort Hood shootings of November 2009, and the initial inaccurate reports, to get an understanding of the problem (e.g., initial reports said the shooter had been killed when he was not). The battle captain is responsible for notifying appropriate people, such as his counterpart at brigade, and others who may need to act on the information, such as the QRF (quick reaction force) or Medevac (medical evacuation). But there is a speed-accuracy tradeoff: the need to act promptly vs. the need to have accurate information. Judging when the time to act is right can be difficult. Wrong or incomplete information can mean loss of life; but so can delay. Various strategies can be used: not acting until the second report [4] or requesting roster numbers of wounded personnel so that the casualty count will be more accurate [12]; but these heuristics are not a total solution. Despite knowing that initial information may not be reliable, Army training emphasizes the value in adopting a solution in a timely manner, instead of waiting for the problem to resolve itself some other way [9]. A summary of leadership "lessons learned" includes the point, *Making a decision in combat (even if it is the wrong decision) is better than inaction* [5].

Various communication failures may also present a challenge to the battle captain. Units may fail to acknowledge a radio communication, or to make routine hourly reports. The battle captain will need to determine whether a communication failure is due to a mundane issue (forgetfulness, technical issues) or whether it is the sign of something more serious. If a unit fails to provide mission updates, for example about an unexpected delay, it can have a series of cascading consequences for synchronization of activities. While it is the unit's responsibility to keep the battle captain updated, if the unit fails to report, the battle captain needs to take action. Thus, the battle captain needs to be sensitive to omissions as well as commissions.

3.2 Balancing Conflicting Goals

The battle captain may have to balance competing needs in a pressured situation. If a platoon is engaged in combat, known as a TIC (troops in contact), the platoon leader will be concerned with directing on-going events and will prioritize the immediate actions of his unit above the need to report to the battalion TOC. At the same time, brigade will be pushing the battalion battle captain to supply details of the TIC [12]. The more the battle captain knows about the situation, the more he may be able to commandeer other assets in the aid of the unit in the TIC. The battle captain will need to balance getting accurate information rapidly against distracting the unit in the TIC [4]. Experienced battle captains

say that dealing with these conflicting pressures is one of the most challenging aspects of the job [12].

4 Progress on Development of BC-ITS

4.1 Domain Analysis and Scope

We analyzed the role of the battalion battle captain in order to determine the learning objectives upon which to base the development of adaptive technology-based training for battle captains, BC-ITS. Our analysis included examination of documents [e.g., [4], [7], [10]], observation of live training exercises, and interviews with experienced battle captains and other subject matter experts (SMEs). We narrowed the scope of BC-ITS to cover the battle captain's role in monitoring current operations (this eliminated several battle captain responsibilities including physical set-up of the TOC, administrative duties, and report writing). Our goal is to enable and encourage thinking skills, not just procedural learning; however, we also recognize that competency in basic procedures is a precursor to higher cognitive processes applied in a domain. Therefore, given variation in student background and knowledge, we cannot ignore the need to assess and train both the well- and the ill-defined aspects of the domain. Based on analysis of the domain, we specified a hierarchical set of learning objectives, with five terminal learning objectives: (1) Help the Commander Manage the Force (understand the mission and battalion capabilities), (2) Maintain Situation Awareness (keep track of events and their implications), (3) Information Management (assemble/assess/filter/pull/push), (4) Decision Making and Action (authority, responsibility, timing), and (5) Help Manage the Fight (anticipate, prioritize). Each terminal learning objective has four to seven sub-objectives, and each of these has one to four sub-sub-objectives, for a total of 63 enabling learning objectives.

These learning objectives will serve as the basis for a "situated tutor," by combining the pedagogical approach of traditional ITS (content selection, coaching, feedback, and scaffolding) with a simulation that embeds the student in an ongoing scenario where skills and knowledge will be applied under realistic conditions [8]. While envisioned to integrate instruction and simulation, our initial focus thus far has been on the simulation, including the key events, the student actions to be supported, and how entities should behave in response to events, actions, and resulting world state changes. These sub-elements must provide students the opportunity to demonstrate the mastery (or lack of mastery) of the learning objectives.

We envision delivering different training scenarios to students of different backgrounds such that less knowledgeable students start out with relatively straightforward scenarios requiring application of battle drills and other standard procedures, while more experienced students may start with less well-defined situations requiring judgment, prioritization, and anticipation. SMEs have told us that prior tactical and staff experiences enhance the effectiveness of a battle captain, and so we are hopeful that a fairly short background questionnaire might

allow us to stream different students into different scenario sequences; however, we have yet to identify the specific learning objectives in our set for which we should expect past tactical or staff experience to show mastery. In the absence of this information, creating scenarios (and instruction) appropriate to different backgrounds would just be a best guess. We therefore need to collect data with respect to this question to design scenarios appropriately.

4.2 Natural Language Processing

The battle captain's job is communication-intensive, therefore BC-ITS requires a method of simulating communication-based interactions. Doing this using a menu-based system would be cumbersome, and limit the training to a predetermined set of options. A major research thrust of this project is therefore the development of a natural language interface, supporting spoken and text-based communication. Developing the ability for BC-ITS to process what the student says or types and respond appropriately raises a number of challenges: (1) achieving a high enough level of speech recognition accuracy, (2) interpreting the meaning expressed in the recognized speech, (3) developing appropriate responses for the simulated characters, (4) using the understanding of the student's language to update the student model, (5) supporting interactive dialogs, which can probe student thought processes. The first major step is to be able to understand and respond to short oral or text communications made by the student. For example, if a student requests that a unit report its position, the system must be able to understand what is being asked, examine the underlying simulation for that unit's position (which is dynamic in the scenario), and respond with the correct grid location.

Ultimately, we aim to be able to understand, analyze, and respond to student multi-sentence situation reports (requested by a simulated superior) or shift change briefs. Having the student make these reports would support training by making the student reflect on the scenario experience and organize their thoughts for oral presentation. This can engage the student more deeply while performing a task that is in fact part of their duties [3], [11]. Being able to analyze these briefings will provide insight into the student's situation awareness and attention which can be used as the basis for providing feedback. Moreover, being able to respond with probing questions and conduct interactive dialogs will support an even deeper level of self-reflection, and support contemplation on more ill-defined aspects of the domain. Understanding the factors a student considered in a decision can be more important than which of the competing decisions was chosen, when trying to teach how to think about a problem or situation.

4.3 Implementation Status

At the time of this writing, we have implemented the BC-ITS environment and have preliminary models for natural language processing. We have put into place the infrastructure for the training we would like to provide, but have yet to tackle implementation for the really challenging ill-defined aspects to be trained. The

system has the ability to deliver pre-training and post-training questionnaires, upfront instruction, and training on how to negotiate the simulation interface; but our main focus here is on the student's scenario-based experience. The interface allows the student to interact (via headset and keyboard) with simulated entities, who can be co-located with him in the TOC, or away from the TOC. These latter communications can be conducted via simulated channels such as FM radios, telephones, or text messaging. Because our natural language processing capability is still a work in progress, the system's understanding of the student's language is echoed back to them. In addition, they can open a complete record of all interactions. This allows the student to review what has already been communicated and/or to retrieve specific information that might be needed. Students can also open several documents and figures, which provide them with reference information that would be available in a real TOC. Finally, a situation awareness map allows "blue force tracking;" that is, automated tracking of digitally equipped units in the field.

We have implemented a single scenario, simulating part of a battle captain's shift in the TOC. The scenario combines application of some well-defined knowledge, in that there exist battle drills for each significant event (patrol vehicle breaks down, patrol in a TIC, patrol suffers casualties). Events unfold over time so that some judgment and initiative can be exhibited over and above mere knowledge of the battle drills; however, the extent of uncertainty is not that great, in that the student is not placed in a situation with competing goals. An automated "coach" tracks student responses to unfolding events and provides proactive hints (which can be solicited or unsolicited), or reactive feedback, via text in the coaching window. Our immediate plans include having Soldiers with different levels and types of experience complete this scenario, to give us a better picture of how those prior experiences influence their ability to carry out the battle captain role in this scenario. These findings can then contribute to future efforts to adapt training scenarios to match student capabilities based on prior experience.

5 Future Directions

5.1 Adapting scenarios

Rather than taking each student through a fixed sequence of pre-scripted and progressively more difficult scenarios, our aim is to be able to present each student with a customized set, which will be determined by the accumulating evidence with respect to their capabilities in the battle captain role. We are currently hypothesizing four different possible starting scenarios, assuming that we can develop the ability to categorize students quickly, prior to training, into one of four types, created by crossing the two factors: low vs. high tactical experience and low vs. high staff experience. Of course, we will also need to be able to identify the acquired skills (or lack of skills) associated with each factor in order to design these initial scenarios appropriately. Performance during each

student's first scenario will allow us to refine our initial estimate of student capabilities, update the student model accordingly, and determine which learning objectives to target in the subsequent scenario. We aim to be able to create these subsequent scenarios "on the fly," as opposed to retrieving them from a library. One feasible way to do this would be to prescript fairly complex scenarios, but with particular events designated available for inclusion or deletion, depending on the state of the student model and level of challenge the student is ready for. Of course, the associated coaching would need to be modified accordingly, as well.

5.2 Interactive Tutoring

As previously discussed, we are hoping to be able to process multi-sentence briefings and to be able to address some of the ill-defined aspects of the domain by conducting interactive dialogs with students. These dialogs would encourage student reflection by posing questions and stimulating the student to think about "what if" possibilities. Rather than advising the student on *what to do* these interactions would provide guidance on *how to think* about the situation, and the possible second-order consequences of different courses of action. Prompts for reflection could be interjected during a scenario (e.g., " think about what the platoon leader is coping with right now"), whereas more extensive Socratic-like dialogs could be reserved for post-scenario discussion. Soldiers are accustomed to performing after action reviews (AAR) following training exercises. A good AAR stimulates the trainees themselves to reflect on what went right, what went wrong, and what to change to improve performance. The instructor serves the role of facilitating this self-examination. The challenge is to stimulate the same kind of self reflection with an automated coach that can guide the student down a productive path.

6 Conclusion

The battle captain domain involves many areas in which it is hard to define correct vs. incorrect performance. An ITS for this domain needs to help a student recognize how to turn raw information into an understanding that can guide his/her course of action. Using spoken language briefings to simulated characters can allow the ITS a window into the student's reasoning, and through interactive probing, help guide the student toward recognizing how to weigh the available information appropriately. Even if the first report is wrong, the student still should take action, while being observant of any facts that bear on the situation at hand, and be ready to adapt to the changes that later reports may bring.

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